Cellular redox homeostasis in plants: violators, protectors, and their modulation

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Abstract
The generation and scavenging of varied reactive species including reactive oxygen species (ROS) during metabolic reactions in varied cellular compartments are usual. At ROS-generation-scavenging-equilibrium, ROS and its reaction products contribute in plant signaling. Notably, the impact of adverse growth conditions on plants is inevitable. These adverse growth conditions cause imbalance between the generation and scavenging of ROS through either elevating the ROS-generation or diminishing their scavenging. In either case, ROS significantly violates the cellular redox homeostasis and thereby impact overall plant health. Key soluble redox compounds ascorbate (AsA) and glutathione (GSH), enzymatic antioxidant such as ascorbate peroxidases (APX); monodehydroascorbate reductase; (MDHAR) and dehydroascorbate reductase (DHAR); catalase (CAT); glutathione reductase (GR); superoxide dismutase (SOD); and some proteinaceous thiol members including thioredoxin (Trx), glutaredoxin (Grx) and peroxiredoxin (Prx) proteins significantly maintain cellular redox homeostasis at its optimum, and protect the cells against the potential damages caused by cellular redox-violators. Notably, the outcome of the interaction between cellular redox homeostasis-violators and protectors can be modulated by many exogenously supplied stimulants. This presentation aims to (i) briefly overview the chemical behavior and production sites of ROS; (ii) highlight dual behavior of ROS through overviewing ROS communication with other signaling molecules; ROS role in stress signaling; and elevated ROS-accrued oxidative damage to biomolecules; (iii) discuss the selected cellular redox homeostasis-protectors; alternative oxidase; respiratory burst oxidase homologs; NADP-dependent malate dehydrogenase and the malate valve; and plastid terminal oxidase; and proteinaceous thiol members; (iv) discuss the selected exogenously supplied stimulants-induced modulation of cellular redox homeostasis-protectors, and also to (iv) highlight major aspects so far little explored on the subject.

Keywords Cellular redox homeostasis; Reactive oxygen species; Oxidative stress; Antioxidant metabolism; Stress tolerance